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DEVELOPMENT OF ELECTRIC POWER EQUIPMENT SECTOR AND TECHNOLOGY UNPACKAGING *

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1. Electrical energy is one of the most important contributors to the industrialization and overall growth of a developing country. All developing countries, therefore, have given high priority to electrification in their economic and social policies and, as a result, the electric power sector has been growing fast in these countries.

2. Investment in the electric power sector is very capital-intensive. Electrification programmes claim one of the largest shares of public investment in most developing countries. Very large investment costs in general, and high foreign currency requirements in particular constitute a major constraint and, at the same time, increase the importance of the role played by multilateral financing organizations.

3. The development and operation of an electric power system involve all the hard- and software activities related to the generation, transmission and distribution of electrical energy. Hardware activities such as manufacture, assembly and repair and maintenance of all related equipment, construction of structures and buildings, and software services such as planning, feasibility studies, consultancy and engineering, contracting, supervision, operation and management and research and development cover a wide spectrum of varying complexity levels. This wide scope which varies from a simple wooden distribution pole to the very complex gas turbine; and from simple civil engineering for rural electrification to very complex large power plant engineering, makes it possible for developing countries to enter into the electric power sector at a complexity level which is compatible with their development stage.

4. In order to be able to fully describe the process of development of the electric power sector, one must take into consideration all the activities mentioned above. This approach, compared with that which focusses on the electric power plant equipment only, makes it possible not to limit targets merely to the production of capital goods, and consequently, not to exclude a large number of developing countries from the scope of discussion. In practice, furthermore, equipment in the strict sense represents on the average only 50% of investments (for a medium voltage distribution line, for example, the share of equipment is even lower).

5. At the world level, the heavy electric power equipment industry is often represented as an oligopoly, or cartel. This statement can be softened in the case of less complex equipment, for which the technology has been mastered in a large number of small- and medium-sized companies in the industrialized countries and in a growing number of developing countries.

6. The following is a brief diagnosis of the present situation in the electric power equipment sector:

a) Worldwide:

- Since 1980, world trade of electric power equipment has been shrinking due to reduced demand in developed countries and financing difficulties faced by developing countries;

- In most developed countries, the domestic market is highly protected. Reduced domestic market, therefore, forces the firms to promote their exports to developing countries;

- The relative importance of the electric power equipment market in the developing countries, which consists of approximately US$ 15 billion per year of imports, mostly from the industrialized countries, has greatly increased by the current decline in the world market;

- The present state of the world market should permit closer commercial and technical co-operation between developed and developing countries.

b) In industrialized countries:

- There is a significant unutilized capacity;

- The concentration of the electric power equipment industry is increasing with an ever decreasing number of firms in manufacturing;

- Overhead costs in general, and R+D costs in particular are soaring;

- As a response to the changing market conditions, not only the Transnational Corporations (TNCs) but also the Small- and Medium-sized Enterprises (SMEs) from developed countries are changing their attitudes toward transfer of technology to the developing countries.

c) In developing countries:

- The production of electric power equipment is concentrated in the Newly Industrializing Countries (NICs);

- The capacity utilization of the existing manufacturing facilities is very low;

- For the less complex equipment there can be room in the world market for manufacturers from the NICs.

7. It is interesting to note that, in most developing countries, the new capacities have been created through turn-key supply arrangements. These arrangements which have a negative impact on the development of an indigenous industry have possibly been made as a result of:

- Policies of packaging of large power generation and transmission projects of high technological complexity, effectively excluding local participation;
- Policies of funding agencies that would actively prejudice against all but established firms;
- De facto actions on the part of, for instance, electric power utility decision makers in the developing countries who may believe that for the reasons of product quality, reliability or consistency or simply from habit that equipment must be purchased from a foreign supplier.

8. In order to reduce the payments in foreign exchange and to increase their self-reliance, the developing countries have to step up their efforts for domestic manufacturing of electric power equipment in whatever modest a way possible. Electricity is an essential component for industrialization. However, the priority for manufacturing electric equipment would depend on the extent of electricity required, patterns of industrialization, priorities of other sectors which may claim skilled personnel and financial resources, etc.

9. The electric power equipment industry is not a prime-mover of and/or an entry route into the capital goods sector. On the contrary, its development depends upon the existing level of the capital goods industry, engineering skills and supply of intermediate goods. For all countries, therefore, there is the question of linkage between the electric power equipment sector and the capital goods sector as a whole.

10. Planning is crucial to the development of the electric power equipment industry. Planning here should be considered in the broader context of integrated energy/industry planning and in particular in the context of the planning of the capital goods industry development.

11. Integrated energy/industry planning involves, on the one hand, estimates of the type and amount of energy needed to achieve the social and economic targets and, on the other hand, identification of industrial inputs required

for energy development. Although the development of electric power system should be considered within the framework of integrated energy/industry plans, policies and strategies for the development of the electric power equipment industry should be based on the sectoral development plan of the capital goods industry.

12. Planning of the electric power sector and implementation of plans are relatively easy when the central role of the State in the sector in developing countries is considered. Almost without exception, the government owned electric utility company is in charge of the development and operation of the power system in developing countries. The purchasing power of the utility company, therefore, is determinant of the indigenization of development and operation of the electric power system.

13. All the hard- and software activities involved in the establishment and operation of electric power systems are defined here as the "technology package". Indigenization of this package is only possible when the contents of the package are progressively mastered. This is by no means an easy task: Constraints such as lack of policies and strategies, market size, technological complexity of equipment, investment costs, financing, lack of negotiation skills, training, standardization, etc. hinder the development and indigenization of the electric power system.

14. To overcome some of the above-mentioned obstacles, various strategies can be followed. One of the favoured approaches is "technology unpackaging". Technology unpackaging is defined here as the capability of breaking down a power system project into its component activities and progressive mastery and/or indigenization of each activity.

15. The main aim of technology unpackaging is to avoid turn-key operations which generally exclude domestic participation. Different unpackaging policies and strategies can be followed to achieve this goal. The policy framework and strategies are dependent not only on the stage of development of individual countries but also on the political choices.

16. The information on individual countries have indicated that irrespective of the differences in approaches to technology unpackaging, the State has

played a central role in every country. Integrated energy/industry planning, formulation and implementation of policies and strategies, and utilization of purchasing power through public utilities emerge as some of the areas in which the State should play an active role.

17. In each country case study carried out for UNIDO, it was clearly indicated that the first step toward technology unpackaging has been the establishment of national engineering and consultancy services. Manpower training, therefore, appears to be the most urgent issue to be dealt with if rapid mastery of technologies is desired.

18. Technology unpackaging, as defined here, involves all activities related to electric power system development. It is, therefore, necessary that unpackaging policies and strategies should also focus on, among others, civil engineering, construction, assembly and repair and maintenance. These activities are generally within the capabilities of many developing countries and constitute a large portion of the total investment.

19. Policies and strategies for the manufacture of electric power equipment, however, should be considered within the capital goods sector as a whole. This requirement is another reason why integrated energy/industry planning in general, and capital goods sectoral planning in particular is very important.

20. The development of an electric power equipment sector together with the software services is a long-term undertaking. The long-term development patterns depend upon the typological characteristics of individual countries and the adopted policies and strategies. Different routes have successfully been tried in different countries. Each route has its own costs and critical success factors. Furthermore, the rate and speed of indigenization could be different in each route.

21. Almost all developing countries give very high priority to rural electrification. It is also true that in many developing countries there is scope for local industries and skills to participate in rural electrification programmes. In particular, the experience with the micro- and mini-hydroelectric projects has already proven this point.

22. It is clear that the development of the capital goods industry in general, and electric power equipment sector in particular calls for, first and foremost, a considerable effort on the part of developing countries themselves. Through such an effort they can build a human potential and an industrial base that enable them to negotiate with the owners of technology and increase their participation in the projects.

23. Technology ownership and manufacturing in the electric power equipment sector is highly concentrated in the developed countries and in a few NICs. International co-operation, therefore, is indispensible if it is desired to develop this sector in the developing countries. Some of the possible areas for co-operation between the industrialized and developing countries and among developing countries themselves are discussed below.

24. Development of the national engineering capacity should be the first activity toward unpackaging. One of the most effective training methods for the technical personnel required by local consultancy and engineering services is to get them involved in the project design studies which are normally carried out in the design office of the supplier. Furthermore, co-operation with independent consultancy and engineering companies from developed countries can help to master the techniques utilized to prepare the feasibility studies, project design, contract negotiation and bid evaluation, project supervision, etc.

25. Surveys of existing hard- and software capabilities in the developing countries and integrating them in the electric power system projects is one of the most important steps toward indigenization. Such surveys could also help to identify the new industrial activities to be promoted. Technological know-how and subcontracting experience are prerequisites to the success of such surveys. At the beginning of the technology unpackaging and indigenization process, the domestic utility company and/or national prime contractor would generally lack the know-how and experience and, therefore, needs the technical assistance of the technology owner and/or manufacturer. Co-operation in this area also provides excellent training opportunities for local engineering personnel and planners.

26. The efficient and uninterrupted operation of the electric power system is dependent mainly on two factors: Proper repair and maintenance of the installations and correct management of operation of the system. Repair and maintenance of generation, transmission and distribution subsystems is a complicated undertaking and, in the long run, could establish the nucleus of manufacturing activities.

27. Training for repair and maintenance should start very early in the system development, preferably during the manufacturing and assembly of equipment. This requirement necessitates the training of personnel at the manufacturer's plant and their full participation in the assembly activities. It is necessary to secure such training programmes and participation in the assembly while negotiating the power system contracts. It should also be remembered that manpower training along the lines mentioned above is indispensible not only for repair and maintenance but also for manufacturing activities to be pursued later.

28. It is interesting to note that the electric power sector calls for a high degree of regional co-operation. Yet, the examples of such co-operation among developing countries are not many. Interconnection of national electricity networks between neighbouring countries could generally be taken as the first step towards regional co-operation. Interconnection, first of all, makes it possible the better utilization of installed generation capacities and easier handling of peak power demands. Secondly, it promotes regional co-operation through which the markets could be expanded to reach economic scales for manufacturing. This puts the neighbouring countries in a stronger negotiating position vis-à-vis the technology owners.

29. One of the main technical barriers hindering regional co-operation is incompatible standards. Standardization, therefore, emerges as the first issue to be dealt with. Every effort should be spent to formulate common standards and to eliminate non-technical and/or commercial reasons for adopting different standards by individual countries of the region.

30. Even without interconnections and/or joint manufacturing projects, it is extremely important that the developing countries exchange technical and

commercial information on their electric power systems. Technology unpackaging in general, and project design, contract negotiation, prices, operation and management in particular, are important areas for information exchange.

31. Joint electric power equipment manufacturing projects between developing countries are another form of co-operation. The parties in such projects may own no technology themselves; in these cases joint technology transfers are necessary. In some other cases, however, one of the parties may have already transferred and/or developed the technology; then the project implementation could be similar to those implemented by a firm from an industrialized country.

32. One of the barriers to co-operation between developing countries is the insufficient institutional framework to promote such co-operation. For this purpose, much work has to be done at regional and international levels. Close co-operation between international organizations concerned with the subject is also needed.

33. An interesting area requiring further investigation is the manufacture of equipment for new and renewable sources of energy (NRSE). In particular, there is scope for international co-operation in the development of small-scale hydro-power. UNIDO's experience has already demonstrated that many developing countries have the basic mechanical production capabilities to participate in mini-hydro projects. In this area, co-operation possibilities between developed and developing countries and among developing countries themselves should further be identified.

34. Manufacture of some other simple NRSE equipment such as bio-gas digesters, solar dryers, etc. offers excellent opportunity to develop rural capital goods industries. Manufacturing of such items could easily be integrated into the larger volume production of simple agricultural machinery, simple food processing equipment, etc.

Points for discussion

35. It is possible to define a progression of goods and services in the electric power sector from the least to the most complex. As developing countries advance in their capabilities they add new and more complex products to the product mix. There is, therefore, a progression along the development line and by and large there is no evidence of a country leap-frogging from a lower manufacturing group to higher levels. Moreover, policies of packaging larger power generation and transmission projects may effectively exclude local participation. Policies by funding agencies or utility decision-makers may also be biased against local production. Policy-makers and funding agencies can, therefore, play an important role in overcoming such a bias against local production of electric power equipment.

36. Considering the importance of energy, and in particular electricity in the industrialization process, the following questions arise:

a) How could two clearly different but closely interlinked concepts, namely, development of electric power system, i.e., electrification, and manufacture of electric power equipment, be integrated within energy/industry and capital goods industry planning?

b) How could the international community assist the developing countries to develop a methodology for integrated energy/industry planning in general, and the capital goods sector and the electric power equipment industry planning in particular?

37 In relation to entry into more advanced stages of production of electric power equipment, the following questions arise:

a) Under which conditions can a developing country enter into the next stage of production of electric power equipment?

b) What would be the main strategical guidelines to establish and develop a national engineering capacity and promote domestic participation in electric power system projects? (Changing strategies applicable to different groups of countries.)

38. In relation to the technology unpackaging issues in the electric power and electric power equipment industries, what would be the relevance of the following in bringing transparency to the technology package and to its components:

a) - Disaggregated cost and complexity analysis of package components;

- Review of practical experiences of different developing countries and their enterprises in applying the unpackaging approach;

- Survey of the strategies of parties involved and infrastructural conditions which determine the success of implemeutation of the unpackaging approach;

- Analysis of critical operational problems faced by all parties involved in planning, designing and executing disaggregated electric power system investment projects;

- Investigation of institutional framework required to promote technology unpackaging in individual countries and foster co-operation between interested parties.

b) What are the most important elements to be considered in the formulation of a basic model for the unpackaging of technology in developing countries?

c) What would be the main strategical guidelines to establish and develop national engineering capacity and promote domestic participation in electric power system projects?

39. As far as the roles of the utilities in developing countries and bilateral and multilateral financing institutions are concerned, the following questions arise:

a) How could the purchasing power of public utilities be used to strengthen the negotiating position of developing countries especially regarding unpackaging of technology and, at the same time, to promote domestic industries?

b) Financing for most of the large electric power projects in developing countries is arranged by bilateral and/or multilateral financing institutions: What are the possibilities of adopting policies by these institutions in order to permit or promote the national participation of developing countries in the implementation of electric power projects?

40. In relation to the co-operation possibilities which exist between developing countries, the following questions arise:

a) What would be the benefits of and possibilities for regional and interregional co-operation among developing countries involving exchange of technical and commercial information, network interconnections, and finally, joint projects?

b) What would be the barriers to co-operation between developing countries in this sector and how could the international community contribute to promote such co-operation?

41. Considering the importance given by many developing countries to rural development in general, and rural electrification in particular, the following questions arise:

a) What could be the impact of electrification on rural development and what are the centralized and decentralized alternatives for rural electrification with possible maximum national participation?

b) What would be the preferred institutional framework to optimize the efforts of all involved parties in the small-scale hydropower development?

c) How could the rural and other small-scale capital goods manufacturing units be also involved in the production of simple energy-related capital goods?